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Fig. 2

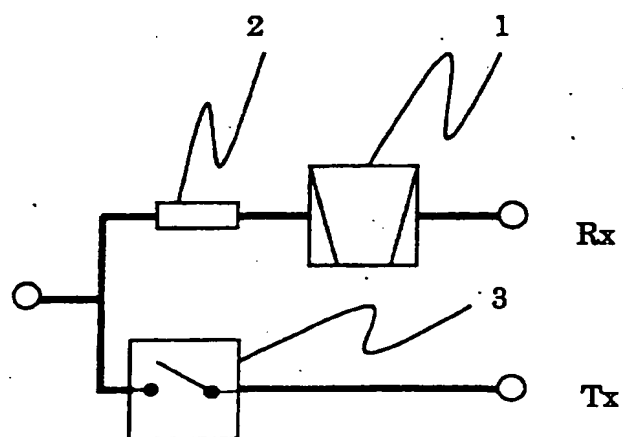
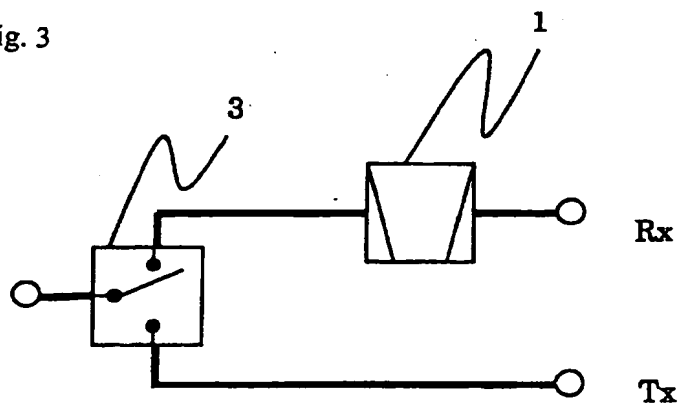


Fig. 3



HIGH-FREQUENCY CIRCUIT DEVICE

The present invention relates to a high-frequency circuit device, and particularly to a duplexer constituted by an surface acoustic wave filter and a RF switch for use as a mobile communication terminal. A high-frequency circuit device according to the present invention is used mainly for a duplexer for a mobile radio terminal with a so-called dual band operation.

Recently, small-size and light-weight mobile communication terminals represented by pocket telephones have been developed at a high pace. Means for separating a transmission signal and a reception signal from each other is indispensable for a pocket telephone because the pocket telephone employs a single antenna which is used for transmission and reception in common with each other. A duplexer constituted by a dielectric resonator or an surface acoustic wave element has been used in the case of an analog system (FDMA: Frequency Division Multiple Access), while an antenna switch circuit using a RF switch, or a duplexer has been used in the case of a digital system (TDMA: Time Division Multiple Access).

As mobile communication has come into wide use, a frequency band near 2 GHz has been put into practical use in addition to a frequency band of 800 MHz developed at the

suppressing the increase of loss with the parallel connection (parallel connection loss) to a minimum. The present invention proposes to make the impedance of the reception surface acoustic wave filter viewed from the parallel connection point substantially opened by using a reception surface acoustic wave filter in which the absolute value of a reflection coefficient of an input terminal in a transmission band is 0.8 or more, and a phase shift circuit connected to the input terminal of this reception surface acoustic wave filter. Here "substantially opened" means that the phase of the reflection coefficient becomes about 0 degree within the transmission band when the absolute value of the reflection coefficient is 0.8 or more. If the above-mentioned condition of "substantially opened" is satisfied, it is possible to suppress the parallel connection loss to 0.5 dB or less. By the above-mentioned means, it is possible to realize a duplexer in which an ON/OFF type RF switch and a reception surface acoustic wave filter are connected in parallel.

That is, in order to achieve the above object, according to an aspect of the present invention, provided is a high-frequency circuit device comprising: an surface acoustic wave filter which has a pass band corresponding to a reception band and a blocking band corresponding to a transmission band, and in which the absolute value of a reflection coefficient in the transmission band viewed from an input terminal is 0.8 or more; a phase shift circuit for making the input impedance of the surface acoustic wave filter substantially opened in the

used as a second transmission/reception band, merely in order to simplify the description.

Fig. 1 is a block diagram illustrating a first embodiment of the present invention, showing an example of the configuration of a duplexer for using both the GSM and PCN systems in common with each other. In the configuration, an surface acoustic wave filter 1 is introduced for GSM reception, in which the reception band of GSM is made to be a pass band with an attenuation property required for the system, while the absolute value of a reflection coefficient of the filter viewed from the input side in the transmission band of GSM is 0.8 or more. One terminal of a phase shift circuit 2 for making the input impedance of the surface acoustic wave filter 1 substantially opened in the transmission band of GSM is connected to an input terminal of the surface acoustic wave filter 1. The other terminal of the phase shift circuit 2 is connected to an ON/OFF type RF switch 3 at a parallel connection point A. An surface acoustic wave filter 4 is introduced for PCN reception, in which the reception band of PCN is made to be a pass band with an attenuation property required for the system, while the absolute value of a reflection coefficient of the filter viewed from the input side in the transmission band of PCN is 0.8 or more. One terminal of a phase shift circuit 5 for making the input impedance of the surface acoustic wave filter 4 substantially opened in the transmission band of PCN is connected to an input terminal of the surface acoustic wave filter 4. The

connection point A through the ON/OFF type RF switch 3. Since the impedance in the transmission band of GSM of the reception circuit side of GSM viewed from the parallel connection point A is substantially opened, the GSM transmission signal passes the low pass filter (LPF) 8 and reaches the parallel connection point C without travelling onto the reception circuit side of GSM. Since the impedance of the transmission/reception circuit side of PCN viewed from the parallel connection point C is made substantially opened by the high pass filter (HPF) 9, the GSM transmission signal is radiated from the antenna without travelling onto the transmission/reception circuit side of PCN.

Only the ON/OFF type RF switch 6 is turned ON at the time of transmission of PCN. A transmission signal which has arrived at from a transmission circuit of GSM reaches the parallel connection point B through the ON/OFF type RF switch 6. Since the impedance in the transmission band of PCN of the reception circuit side of PCN viewed from the parallel connection point B is substantially opened, the PCN transmission signal passes the high pass filter (HPF) 9 and reaches the parallel connection point C without travelling onto the reception circuit side of PCN. Since the impedance of the transmission/reception circuit side of GSM viewed from the parallel connection point C is made substantially opened by the low pass filter (LPF) 8, the PCN transmission signal is radiated from the antenna without travelling onto the transmission/reception circuit side of GSM.

components in a transmission signal is omitted merely for the sake of simplification. As is apparent from the comparison of Fig. 2 with Fig. 3, a so-called SPDT (Single Pole Dual Throw) type switch having two outputs for one input is required in the configuration according to the conventional technique in order to eliminate the influence of the reception circuit at the time of transmission. On the other hand, in the configuration according to the present invention in which the phase shift circuit 2 is provided, a simple ON/OFF type RF switch can be employed because the impedance of the reception filter 1 is substantially opened in the transmission frequency. The ON/OFF type switch can be constituted by one transistor, one FET or one diode at the minimum, while at least two or more transistors, FETs or diodes are required to constitute the SPDT type switch. Thus, it is possible to constitute the ON/OFF type switch in a smaller size and at a lower price than the SPDT type switch.

Next, using a more detailed circuit diagram of Fig. 4, description will be made about of the dual-band duplexer shown by the block diagram in Fig. 1. A phase shift circuit (corresponding to the phase shift circuit 2 in Fig. 1) is constituted by an inductor 22 and capacitors 21 and 23, and connected between the surface acoustic wave filter 1 and the parallel connection point A. A bias circuit is constituted by an inductor 30 and a capacitor 28, and DC blocking capacitors 29 and 31 are connected to the bias circuit. The bias circuit with the DC blocking capacitors 28 and 31 is connected to the

impedance of this low pass filter viewed from the parallel connection point C is made substantially opened in the transmission and reception bands of PCN. A high pass filter constituted by inductors 44 and 46 and a capacitor 25 is connected between the parallel point B and the parallel point C. This high pass filter has a pass band in the transmission and reception bands of PCN and has an attenuation band in the transmission and reception bands of GSM, and the impedance of this high pass filter viewed from the parallel connection point C is made substantially opened in the transmission and reception bands of PCN. Generally, the parallel connection point C is made to be a connection point with an antenna. Bias terminals Vcnt1 and Vcnt2 are led out from the connection point between the inductor 30 and the capacitor 29 constituting one bias circuit and the connection point between the inductor 50 and the capacitor 49 constituting the other bias circuit as illustrated. If control voltages for switching are applied to the bias terminals Vcnt1 and Vcnt2, it is possible to control the ON/OFF of the RF switch.

Although an example in which the bias circuits 28, 29, 30, 48, 49 and 50 for the RF switch are constituted by lumped element circuits providing parallel resonance are shown in Fig. 4, it is obvious that the influence of bias terminals can be avoided even if used is a distributed element line in which the electrical length at the transmission signal frequency is about a quarter of the wavelength of the transmission signal frequency.

CLAIMS

1. A high-frequency circuit device comprising:

an surface acoustic wave filter having a pass band which is a reception signal band and having a blocking band which is a transmission signal band, the absolute value of a reflection coefficient in said transmission signal band viewed from an input terminal of said surface acoustic filter being 0.8 or more;

a phase shift circuit for making the input impedance of said surface acoustic wave filter substantially opened in said transmission signal band; and

an RF switch having a bias circuit in which pass loss in said transmission signal band can be switched in accordance with existence of application of a voltage from an external circuit;

wherein one terminal of said phase shift circuit is connected to said input terminal of said surface acoustic wave filter, while the other terminal of said phase shift circuit is connected to an output terminal of said RF switch.

2. A high-frequency circuit device according to Claim 1, wherein said phase shift circuit is constituted by a concentrated constant element constituted by an inductance element and a capacitance element.

3. A high-frequency circuit device according to Claim 1, wherein said bias circuit is constituted by a concentrated constant element constituted by an inductance element and a capacitance element.

a second phase shift circuit for making the input impedance of said second surface acoustic wave filter substantially opened in said second transmission signal band;

a second RF switch having a bias circuit in which pass loss in said second transmission signal band can be controlled in accordance with existence of application of a voltage from an external circuit; and

a low pass filter having a pass band which is the first reception signal band and the first transmission signal band, and having a blocking band which is the second reception signal band and the second transmission signal band;

a high pass filter having a pass band which is the second reception signal band and the second transmission signal band, and having a blocking band which is the first reception signal band and the first transmission signal band;

wherein one terminal of said first phase shift circuit is connected to said input terminal of said first surface acoustic wave filter, while the other terminal of said first phase shift circuit, an output terminal of said first RF switch and one terminal of said low pass filter are connected to each other;

wherein one terminal of said second phase shift circuit is connected to said input terminal of said second surface acoustic wave filter, while the other terminal of said second phase shift circuit, an output terminal of said second RF switch and one terminal of said high pass filter are connected to each other; and



Application No: GB 9825099.6
Claims searched: 1 to 10

INVESTOR IN PEOPLE
Examiner: Ken Long
Date of search: 24 May 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.Q): H4M (MD)
LECS (V & X)

Int CI (Ed.6): H04B (1/50 and 1/52)
H01P (1/213)
H04J (3/10)

Other: ONLINE : EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	EP 0851526 A2 MURATA	None
A	EP 0818883 A2 LK-PRODUCTS	None
A	GB 2257335 A LK-PRODUCTS	None

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